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An EOQ model under retailer partial trade credit policy in supply chain

Yung-Fu Huang[a], Kuang-Hua Hsu[b,*]

[a]Department of Marketing and Logistics Management, Chaoyang University of Technology, Taichung, Taiwan, ROC
[b]Department of Finance, Chaoyang University of Technology, Taichung, Taiwan, ROC

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Abstract

The main purpose of this paper is to investigate the retailer's inventory policy under two levels of trade credit to reflect the supply chain management situation. In this paper, we assume that the retailer has the powerful decision-making right. So, we extend the assumption that the retailer can obtain the full trade credit offered by the supplier and the retailer just offers the partial trade credit to his/her customer. Then, we investigate the retailer's inventory system as a cost minimization problem to determine the retailer's optimal inventory policy under the supply chain management. Two easy-to-use theorems are developed to efficiently determine the optimal inventory policy for the retailer. We deduce some previously published results of other researchers as special cases. Finally, numerical examples are given to illustrate the theorems and obtain a lot of managerial phenomena.

Keywords: EOQ; Inventory; Partial trade credit; Supply chain

1. Introduction

The traditional economic order quantity (EOQ) model assumes that the retailer's capitals are unrestricting and must be paid for the items as soon as they are received. However, this may not be true. In practice, the supplier will offer the retailer a delay period, that is the trade credit period, in paying for the amount of purchasing cost. Before the end of the trade credit period, the retailer can sell the goods and accumulate revenue and earn interest. A higher interest is charged if the payment is not settled by the end of the trade credit period. In the real world, the supplier often makes use of this policy to promote his/her commodities.

Goyal (1985) established a single-item inventory model under trade credit. Chung (1998) developed an alternative approach to determine the EOQ under the condition of trade credit. Aggarwal and Jaggi (1995) considered the inventory model with an exponential deterioration rate under the condition of trade credit. Chang et al. (2002) extended this issue to the varying rate of deterioration. Liao et al. (2000) and Sarker et al. (2000a) investigated this topic with inflation. Jamal et al. (1997) and Chang and Dye (2001) extended this issue with allowable shortage. Chang et al. (2001) extended this issue

*Corresponding author. No. 168, Jifong E. Road, Wufong Township, Taichung County 41349, Taiwan, ROC.
Tel.: +886 4 247 39 477; fax: +886 4 247 29 772.
E-mail addresses: huf@cyut.edu.tw (Y.-F. Huang), khhsu@cyut.edu.tw (K.-H. Hsu).

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with linear trend demand. Chen and Chuang (1999) investigated a light buyer's inventory policy under trade credit by the concept of discounted cash flow. Hwang and Shinn (1997) modeled an inventory system for a retailer's pricing and lot-sizing policy for exponentially deteriorating products under the condition of permissible delay in payment. Jamal et al. (2000) and Sarker et al. (2000b) addressed the optimal payment time under permissible delay in payment with deterioration. Teng (2002) assumed that the selling price is not equal to the purchasing price to modify Goyal's model (1985). Chung et al. (2002) discussed this issue under the selling price not equal to the purchasing price and different payment rule. Shinn and Hwang (2003) determined the retailer's optimal price and order size simultaneously under the condition of order-size-dependent delay in payments. They assumed that the length of the credit period is a function of the retailer's order size, and also the demand rate is a function of the selling price. Chung and Huang (2003) extended this problem within the economic production quantity (EPQ) framework and developed an efficient procedure to determine the retailer's optimal ordering policy. Huang and Chung (2003) extended Goyal's model (1985) to cash discount policy for early payment. Salameh et al. (2003) extended this issue to the continuous review inventory model. Chang et al. (2003) and Chung and Liao (2004) dealt with the problem of determining the EOQ for exponentially deteriorating items under permissible delay in payments depending on the ordering quantity. Chang (2004) extended this issue to inflation and finite time horizon. Huang (2004) investigated that the unit selling price and the unit purchasing price are not necessarily equal within the EPQ framework under a supplier's trade credit policy. There are several interesting and relevant papers related to trade credit such as Chung et al. (2005), Chung and Liao (2006), and Huang (2007) and their references.

All the above articles assumed that the supplier would offer the retailer a delay period and the retailer could sell the goods and accumulate revenue and earn interest within the trade credit period. They implicitly assumed that the customer would pay for the items as soon as the items are received from the retailer. That is, they assumed that the supplier would offer the retailer a delay period but the retailer would not offer the trade credit period to his/her customer in previously published results. That is one level of trade credit. In most business transactions, this assumption is unrealistic. Recently, Huang (2003) modified this assumption to assume that the retailer will adopt the trade credit policy to stimulate his/her customer demand to develop the retailer's replenishment model. That is two levels of trade credit. This new viewpoint is more matched to real-life situations in the supply chain model. Therefore, we want to extend Huang's model (2003) to investigate the situation under which the retailer has the powerful decision-making right. That is, we want to assume that the retailer can obtain the full trade credit offered by the supplier and the retailer just offers the partial trade credit to his/her customer. In practice, this circumstance is very realistic. For example, the Toyota Company can require his supplier to offer the full trade credit to him and just offer partial trade credit to his dealership. That is, the Toyota Company can delay the full amount of purchasing cost until the end of the delay period offered by his supplier. But the Toyota Company only offers partial delay payment to his dealership on the permissible credit period and the rest of the total amount is payable at the time the dealership places a replenishment order. In addition, we want to relax three assumptions in Huang's model (2003) that unit purchasing price equals unit selling price, $c = s$, interest charge rate is larger than interest earned rate, $I_k \geqslant I_e$, and the retailer's trade credit period offered by the supplier is longer than the customer's trade credit period offered by the retailer, $M \geqslant N$. Under these conditions, we model the retailer's inventory system as a cost minimization problem to determine the retailer's optimal ordering policies.

2. Model formulation and convexity

The following notation and assumptions will be used throughout:

Notation

D	demand rate per year
A	ordering cost per order
c	unit purchasing price
s	unit selling price, $s \geqslant c$
h	unit stock-holding cost per year excluding interest charges
α	customer's fraction of the total amount owed payable at the time of placing an order offered by the retailer, $0 \leqslant \alpha \leqslant 1$
I_e	interest earned per \$ per year